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# GAS "TRUE" CONVECTION BAKE OVEN

## Background

### Field of the Invention

**[0001]** The invention relates in general to the field of food preparation ovens, and specifically to a gas "true" convection oven.

### Description of the Related Art

**[0002]** Convection ovens have long been popular in the cooking industry for both residential and commercial use. Typically, a gas convection oven involves a heat source disposed underneath the oven cavity, and a fan within the cooking cavity to circulate the hot air in the cooking cavity. This arrangement has the disadvantage that the air being blown through the fan is only as hot as the air within the oven cavity. Thus the heating of the food in the oven is uneven and much of the heat from the heat source is lost.

**[0003]** In order to improve the heating efficiency and increase oven temperatures, it was contemplated to provide a heat source in close proximity to the fan such that the air being moved by the fan is hotter than the air within the oven cavity. Thus food products within the oven are heated uniformly by air of a higher temperature, thus increasing heat transfer efficiency between the air and food products and reducing cooking times. This arrangement is typically termed "true convection" in the cooking appliance industry. Essentially, the term "true convection" refers to an oven in which a burner, or heat source is disposed in close proximity to the fan and that the air passing through the fan and into the oven cavity is at a higher temperature than the air within the oven, thus the heat is convectively transferred from the hot, moving air to the food products within the oven.

**[0004]** Such "true" convection environments are typically created with an electric heat source disposed immediately in front of, behind, or surrounding the convection fan. This convection heat source is typically provided in addition to heat sources for standard non-convective baking. This has the result of significantly increasing the cost of the oven due to the fact that the oven must be adapted to operate multiple heat sources of various type and size. When the standard heat source is a gas burner or broiler, the oven must be adapted

to operate with both gas and electrical power. Additionally, it is difficult to install a gas burner in close proximity to the fan, as the turbulence caused by the fan will greatly affect flame stability and emission. It has also been difficult to design a gas burner which can function in both fan-on and fan-off conditions.

**[0005]** It is therefore desirable to create a gas "true convection" cooking environment in an oven without the necessity of multiple heat sources, while providing the ability to draw hot air from a heating source with stable combustion conditions.

Summary

**[0006]** Therefore an oven is described herein which is capable of producing a "true convection" environment with a single gas burner disposed underneath the oven bottom in a combustion box, and a flue spout disposed at the rear of the oven and attached to a fan to draw hot air and flue products directly from the burner within the combustion box and blow them into the oven cavity.

**[0007]** Thus, one embodiment of an oven having preferred features and advantages includes an oven comprising an oven cavity defined by a plurality of side walls, a bottom wall, a top wall, a back wall, and a door. A fan compartment is disposed substantially centrally on the back wall, and is defined by a baffle plate spaced forwardly from the back wall, a plurality of rearward-extending flanges, and a portion of the back wall. A centrifugal fan is preferably disposed within the fan compartment, and the baffle plate preferably has a central fan-inlet portion. A combustion box having a front wall, a rear wall, a plurality of side walls and a bottom wall is preferably mounted to an underside of the oven bottom. A tube-type gas burner having a longitudinal axis perpendicular to the oven side walls is preferably disposed in a forward portion of the combustion box. A flue spout is preferably disposed between the baffle plate and the oven cavity, and is preferably adapted to join the fan compartment and the combustion box in fluid communication.

**[0008]** The baffle plate preferably comprises peripheral outlets. In one preferred embodiment, the combustion box bottom comprises a rearward, upward slope, the front side of the combustion box comprises a plurality of primary air inlet holes, and the bottom of the combustion box preferably comprises a plurality of secondary air inlet holes. The oven may include exhaust vents located substantially near the bottom of the back wall. Openings may be formed in the oven bottom to provide direct fluid communication between the oven cavity

and the combustion box. In one embodiment, the flue spout comprises an upper portion which covers substantially the entire fan inlet. Alternatively, in another embodiment, the flue spout upper portion covers substantially half of the fan inlet portion of the baffle plate. The fan compartment may also comprise an opening in its top or other flange.

**[0009]** Another embodiment of an oven having preferred features and advantages includes an oven cavity defined by two upright side walls, a bottom, a top, a back wall, and a door, the bottom having openings joining the oven cavity and the combustion box in fluid communication. A baffle plate having a central fan inlet portion and peripheral fan outlet portions preferably forms the front of a fan compartment disposed substantially at the center of the back wall. The fan compartment is preferably defined by the baffle plate, a plurality of rearward-extending flanges, and a portion of the back wall. A centrifugal fan is disposed within the fan compartment. A combustion box having a front wall, a rear wall, a plurality of side walls and a bottom is preferably mounted substantially centrally to an underside of the oven bottom. A flue spout with a solid front wall is preferably disposed between the baffle plate and the oven cavity, and preferably joins the fan compartment and the combustion box in fluid communication. According to this embodiment, the fan inlet is preferably substantially entirely covered by the flue spout. A tube-type gas burner having a longitudinal axis perpendicular to the oven side walls, is disposed in the front of the combustion box.

**[0010]** Additionally, the combustion box bottom may comprise a rearward, upward slope, the front side of the combustion box may comprise a plurality of primary air inlet holes, and/or the bottom of the combustion box may comprise a plurality of primary air inlet holes. The combustion box bottom may additionally comprise a plurality of secondary air inlet holes. The oven may include exhaust vents located substantially near the bottom of the back wall. The oven top preferably does not have a fan compartment attached thereto. The fan compartment may also comprise an opening in its top or other flange.

**[0011]** According to another preferred embodiment, an oven having desired features and advantages may include an oven cavity defined by a plurality of walls, a bottom, a top wall, a back wall, and a door; a combustion box having a plurality of upright walls and a bottom wall, the box being mounted to an underside of the oven bottom; the oven bottom having openings joining the oven cavity and the combustion box in fluid communication; a baffle plate having a central fan inlet and peripheral fan outlets; a fan compartment disposed

substantially centrally on the back wall, and defined by the baffle plate, a plurality of rearward-extending flanges, and a portion of the back wall; a centrifugal fan disposed within the fan compartment; a tube-type gas burner disposed substantially near and parallel to the front wall of the combustion box; and a flue spout having a front wall, a top wall, a plurality of rearward-extending sides, and a lower inlet portion, the inlet portion being substantially wider than the top wall, the flue spout being disposed between the baffle plate and the oven cavity such that the inlet portion extends into the combustion box, and the flue spout covers a portion of the fan inlet such that the flue spout is placed in fluid communication with the fan compartment.

**[0012]** Additionally, according to this embodiment, the fan inlet may be substantially entirely covered by the flue spout, and the flue spout may be adapted to allow only heated air from the combustion box to enter the fan inlet. Exhaust vents are preferably located substantially near the bottom of the back wall.

**[0013]** According to still another embodiment, a method of convectively cooking a food product comprises the steps of providing an oven having a cooking space, a combustion box disposed below the cooking space, a fan compartment disposed at the rear of the cooking space, and providing a flue spout disposed to join the combustion box, the fan compartment, and the cooking space in fluid communication; providing a fan in the fan compartment; providing a gas burner in a front portion of the combustion box; igniting the burner and heating air in the combustion box; and employing the fan to draw heated air directly from the gas burner in the combustion box through the flue spout, and blowing the heated air horizontally into the cooking space.

**[0015]** Alternatively, the method may include providing fluid communication between the cooking space and the fan compartment with intake holes, and using the fan to draw air from the cooking space into the fan compartment and mixing the cooking space air with the combustion box air.

**[0016]** In another embodiment, the method includes providing fluid communication between the cooking space and the fan compartment with intake holes in a wall of the fan compartment, and using the fan to draw air from the cooking space into the fan compartment and mixing the cooking space air with the combustion box air, and blowing the mixed air horizontally into the cooking space.

[0017] For purposes of summarizing the invention and the advantages achieved over the prior art, certain objects and advantages of the invention have been described herein above. Of course, it is to be understood that not necessarily all such objects or advantages may be achieved in accordance with any particular embodiment of the invention. Thus, for example, those skilled in the art will recognize that the invention may be embodied or carried out in a manner that achieves or optimizes one advantage or group of advantages as taught herein without necessarily achieving other objects or advantages as may be taught or suggested herein.

[0018] All of these embodiments are intended to be within the scope of the present invention herein disclosed. These and other embodiments of the present invention will become readily apparent to those skilled in the art from the following detailed description of the preferred embodiments having reference to the attached figures, the invention not being limited to any particular preferred embodiment(s) disclosed.

## Brief Description of Drawings

[0019] Having thus summarized the general nature of the invention, certain preferred embodiments and modifications thereof will become apparent to those skilled in the art from the detailed description herein having reference to the figures that follow, of which:

[0020] FIG. 1 is an orthogonal view of an oven having preferred features and advantages;

[0021] FIG. 2 is a front view of the oven of FIG. 1;

[0022] FIG. 3 is a side section view of the oven of FIG. 1, showing a preferred flow pattern; and

[0023] FIG. 4 is a top view of the oven of FIG. 1, showing a preferred flow pattern.

## Detailed Description

[0024] A gas 'true' convection bake oven having preferred features and advantages is shown in **Figures 1 - 4**. Specifically, an oven **10** is shown comprising an oven cavity **12** defined by two upright side walls **14**, a bottom wall **16**, a top wall **18**, a back wall **20**, and a door **22**. The back wall **20** of the oven **10** preferably includes one or more exhaust vents **24**. At the rear of the oven cavity **12** and adjacent the back wall **20**, is preferably a fan compartment **26** defined by a baffle plate **28**, and top **30**, side **32**, and bottom **34** flanges. A combustion box **36** is disposed below the oven bottom wall **16**, and includes a gas burner **38**. Disposed between the

baffle plate **28** and the oven cavity **12** is preferably a flue spout **40**. The lower end **42** of the flue spout **40** is in fluid communication with the combustion box **36**, and the upper end **44** of the flue spout **40** preferably covers a portion of the baffle plate **28**. The open space within the oven cavity provides a cooking space into which can be placed a food product to be cooked by gas "true" convection as described below.

**[0025]** As mentioned above, and as best seen in **Figures 2 & 3**, the combustion box **36** contains a tube-type gas burner **38**. As seen best in **Figure 2**, the burner **38** preferably extends substantially across the front of the combustion box **36** such that the longitudinal axis of the burner is substantially parallel to the longitudinal axis of the combustion box front wall **52**. The combustion box **36** includes two side walls **48**, a back wall **50**, a front wall **52**, and a bottom **54**. The front wall **52** of the combustion box **36** is preferably substantially rectangular, and includes primary air intake holes **56**. The bottom **54** of the combustion box **36** is preferably substantially sloped upward from front to rear (see **Figure 3**). The combustion box bottom **54** may also comprise secondary air inlet holes **58** substantially near the back wall **50** of the box **36**. The combustion box **36** may additionally include primary air intake holes **60** immediately below the burner **38**. The box **36** is preferably sized and positioned such that the burner **38**, disposed in the front of the box **36**, is substantially close to the front of the oven **10**, thus providing a substantial horizontal distance between the burner **38** and the intake portion **42** of the flue spout **40**. The box **36** is also preferably sized such that the burner **38** is a substantial vertical distance below the oven bottom wall **16**. The specific advantages of this geometry will be discussed below. Air inlet holes **60** and **56** are preferably sized to allow a sufficient volume of air to enter the combustion box to allow for complete combustion. Inlet holes **60** and **56** are generally sized to allow a sufficient amount of air to enter for the particular burner to be used. The size of the inlet holes is generally dependent on such factors as the total BTU rating of the burner, the particular fuel type, and oven cavity size.

**[0026]** With reference to **Figure 3**, the oven bottom wall **16** preferably includes a thin-walled raised portion **62** in fluid communication with the combustion box **36**. In one embodiment, the oven bottom wall **16** includes longitudinal openings **64** extending parallel to the oven side walls **14**, and in fluid communication with the combustion box **36**. The openings preferably comprise longitudinal elliptical or rectangular holes in the oven bottom wall **16** covered by long raised manifolds **68**. Alternatively, the openings **64** may comprise a plurality

of circular, elliptical, or rectangular holes in the oven bottom wall **16**. The manifolds **68**, if present preferably comprise a top and a back (see Figure 2), and are preferably open on the edge nearest the oven side walls **14**. The openings **64** provide the advantage of allowing the oven to be operated in both fan-off and fan-on conditions.

**[0027]** Those skilled in the art will understand how to build a suitable tube-type gas burner **38** for use in an oven having preferred features and advantages. A suitable burner **38** is preferably capable of being used in a typical non-convective bake mode in addition to the 'true' convection mode as discussed herein. The burner **38** preferably has gas outlet holes **70** substantially on the top and rear sides of the tube **38**. The burner **38** is preferably ignited by a hot surface ignitor, but may alternatively be ignited by an electric spark ignition or pilot flame, or other ignition method known to those skilled in the art.

**[0028]** With reference to **Figures 1 & 2**, a fan compartment is preferably disposed adjacent to the back wall **20**, centered relative to the side walls **14**, and may be centered relative to the oven top **18** and bottom wall **16**. The baffle plate **28** defines the front of the fan compartment **26**. Attached to the baffle plate **28**, and extending rearward, are preferably side **32**, bottom **34**, and top **30** flanges. The flanges may cover substantially all, or only a portion of the space between the baffle plate edges, and the back wall. For example, **Figure 1** shows the fan compartment top flange **30** having an open section, through which heated air and flue products may flow. The flanges **30, 32, 34** are preferably formed as a unitary piece of material with the baffle plate **28**, however they may alternatively be welded or otherwise attached. The flanges **30, 32, 34** are preferably attached to the back wall **20** by rivets, bolts, screws, welds, or other appropriate fasteners. As best seen in **Figure 2**, the baffle plate **28** preferably comprises a plurality of openings **72** situated substantially at its center (which is preferably located substantially at the center of the centrifugal fan **74, Figure 3**). The openings **72** at the center of the baffle plate **28** define a fan inlet **72**. Located peripherally in the baffle plate **28**, are preferably a series of holes defining fan outlets **76**. The flanges **30, 32, 34** of the fan compartment may also comprise openings forming further fan outlets.

**[0029]** As seen best in **Figure 2**, the solid front wall **39** of the flue spout **40** preferably comprises a substantially trapezoidal shape, such that the upper end **44** is preferably about the width of the total fan inlet **73**, and the lower end **42** is substantially wider than the upper end **44**. The bottom **42** of the flue spout **40** preferably forms an opening which extends

substantially across the entire width of the bottom of the flue spout **40** such that the flue spout 40 is in fluid communication with the combustion box **36**. The solid front wall **39** of the flue spout **40** is preferably positioned substantially upright and spaced forwardly from the baffle plate **28**, and has a plurality of flanges extending rearward toward the baffle plate **28** which define flue spout sides. The upper portion **44** of the flue spout **40** is preferably adapted to cover a substantial portion of the fan inlet **72**. For example, the flue spout **40** may be adapted to cover substantially half of the fan inlet **72**, or alternatively, as shown in Figure 2, the flue spout **40** may be sized and disposed such that it covers substantially the entire fan inlet portion **72** of the baffle plate **28**. In still another embodiment, the flue spout **40** may cover less than half of the fan inlet portion **72** of the baffle plate **28**. The flue spout **40** may comprise openings on either side of its upper portion **44** such that oven air may enter and mix with the flue products before entering the fan compartment **26**.

**[0031]** **Figures 3** and **4** illustrate preferred air flow patterns during operation of the oven **10** in its gas 'true' convection mode. During operation, the burner **38** will be lit, thus heating air and expelling hot flue gasses into the combustion box **36**. In gas 'true' convection mode, the fan **74** will pull hot air and flue products from the combustion box **36** into the flue spout intake, up through the flue spout **40**, through the fan inlet **72**, and into the centrifugal fan **74** as indicated by arrows **100** in **Figure 3**. The centrifugal fan **74** will then push the air out through the fan outlets **76** as shown by arrows **104**. In the embodiment of **Figure 3**, the fan compartment **26** comprises a fan outlet formed in its top flange **30**, and the embodiment of Figure 4 shows flow patterns through fan outlets formed in the baffle plate **28**. Those skilled in the art will recognize that the horizontal (rear-to-front in the embodiments shown) movement of air through the oven cavity **12** has the advantage of providing even heating to food products on multiple, vertically displaced trays, whereas a vertically upward or downward flow of air would only effectively heat a single lower or upper tray respectively. If the flue spout **40** covers less than the entire fan inlet **72**, (as is the case in **Figure 1**), the heated air from the oven cavity **12** will re-enter the fan **74** through the uncovered portion of the fan inlet **72**, and be re-circulated through the fan **74** and back into the oven cavity **12** as indicated by arrows **108** in **Figure 4**.

**[0032]** Alternatively, if the entire fan inlet **72** is covered by the flue spout **40**, thus disallowing the re-circulation of the oven cavity air, only the heated flue products and secondary air will be blown into the oven cavity **12**. As mentioned above, the combustion box **36**

preferably has secondary air inlet holes **58** in its bottom **54**, located toward the rear of the oven. Thus, as indicated by arrows **112**, secondary air will be pulled in through these holes **58** and will mix with the hot flue products, thus alleviating the effect on the burner **38** of the increased suction pressure in the combustion box **36**.

**[0033]** In another embodiment, the bottom of the oven includes openings **64** in fluid communication with the combustion box **36**. According to this embodiment, hot air and flue products will flow out of the combustion box **36**, as illustrated by arrows **116** and into the oven cavity. Air entering the center of the oven cavity **12** from the fan **74**, will circulate throughout the oven cavity before exiting through the outlet vents **24**.

**[0034]** Those skilled in the art will recognize that the above-described exemplary flow patterns represent only some of the possible flow patterns achievable with an oven **10** as shown and described herein. The amount of flow through the openings **64** in the oven bottom **16** may vary depending on the flow rate of the air being moved by the fan **74**, the presence of additional inlet holes, and the specific size of the openings **64** themselves. Those skilled in the art will recognize the various advantages of such arrangements.

**[0035]** In all of the above embodiments, air will be vented out of the oven cavity **12** through the exhaust vents **24** located toward the bottom of the rear wall **20** of the oven **16** (shown by arrows **120**). By providing exhaust vents **24** at the bottom of the back wall **20**, the desired hotter air will preferably remain in the oven cavity **12** while the cooler air, closer to the bottom of the oven cavity **12** will be vented out to the atmosphere and therefore improving heat transfer efficiency. Of course, those skilled in the art will recognize that the exhaust vents may be located toward the top of the back wall **20**, or any other appropriate location.

**[0036]** An oven having features described herein will, for example, provide the following advantages. The orientation and remote location of the burner **38** relative to the flue spout intake allows the hot air and flue products to be drawn out of the combustion box **36** without significantly affecting the burner ignition or continued efficient combustion. At the same time, the illustrated arrangement provides desirable heating in a fan-off baking mode. The secondary air inlet holes **58** further contribute to the completeness of combustion.

**[0037]** As mentioned above, an oven having preferred features and advantages may also be used in a standard non-convective bake mode. In this standard bake mode, the fan **74** remains off, and all air flow will be driven by buoyancy and thermally-induced pressure

gradients. The heat produced by the burner **38** will heat the air in the combustion box, and will be conducted through the thin-walled oven bottom wall **16**. The hot air and flue products in the combustion box **36** will create substantially uniform heating of the oven bottom wall **16**. Hot air and flue products will flow up through the openings **64**, through the manifolds **68** and into the oven cavity **12**, and eventually out through the exhaust vents **24**. Additionally, a portion of the hot air and flue products will rise up through the flue spout **40**, into the oven compartment **12**, and out through the exhaust vents **24**.

**[0038]** Thus the oven **10** as described herein is capable of being operated in standard bake mode (i.e. with convection fan off) in which heat and flue gasses from the burner are transferred up through the openings **64** in the oven bottom and into the oven cavity **12**; or in a gas 'true' convection bake mode in which hot flue products created by the burner **38** are drawn from the combustion box **36**, and are blown into and throughout the oven cavity **12** by a centrifugal convection fan **74**. Thus a gas 'true convection' environment is created by an oven as described herein due to the increased temperature of the air being blown into the oven cavity relative to the temperature of the air previously within the oven cavity.

**[0039]** Although certain preferred embodiments and examples have been described herein, it will be understood by those skilled in the art that the present inventive subject matter extends beyond the specifically disclosed embodiments to other alternative embodiments and/or uses of the invention and obvious modifications and equivalents thereof. Thus, it is intended that the scope of the present inventive subject matter herein disclosed should not be limited by the particular disclosed embodiments described above, but should be determined only by a fair reading of the claims that follow.